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(54) **Broadband long-distance optical fibre communications**

(57) The communications system comprises interleaved optical fibre lengths 8, 9 of two types, each type on a corresponding side of an optical amplifier 3. In order to prevent chromatic dispersion throughout the operating wavelength bandwidth of the system (which may be as wide as 50nm) the two types of fibre must have equal and opposite non-zero dispersions throughout the wavelength bandwidth (and so, one the gradient of the dispersion-versus-wavelength characteristic of one must be positive, of the other negative).

FIG. 1

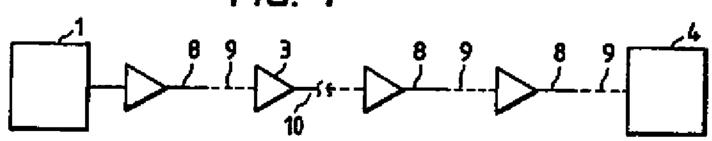

FIG. 3

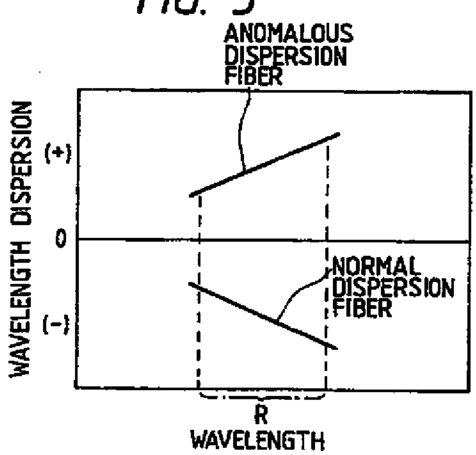

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FIG. 1

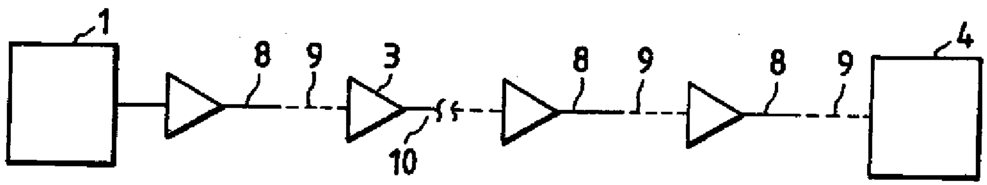


FIG. 2

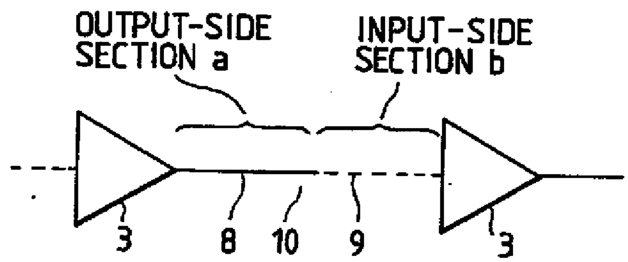


FIG. 3

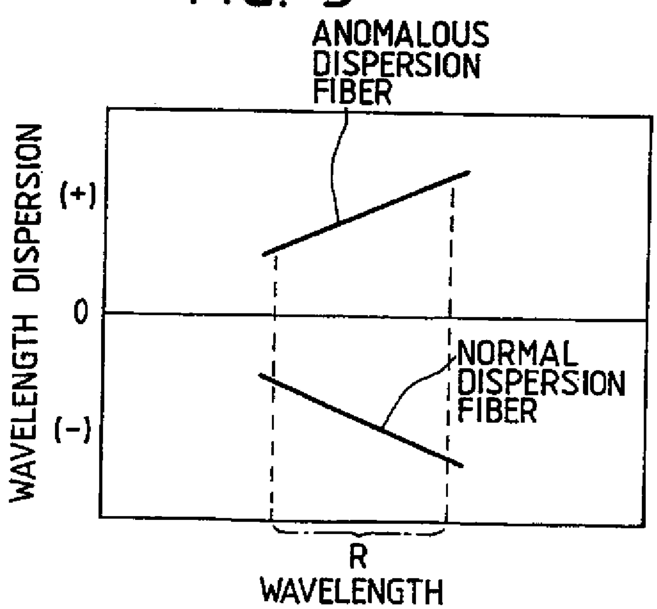


FIG. 4

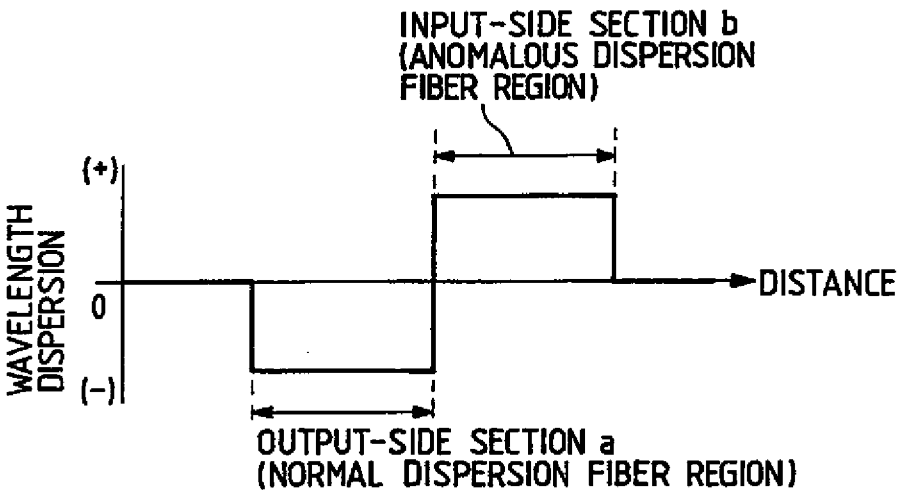


FIG. 5

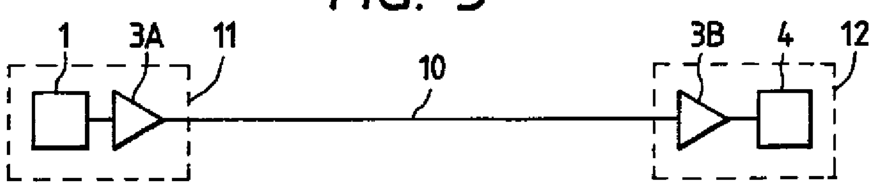


FIG. 6

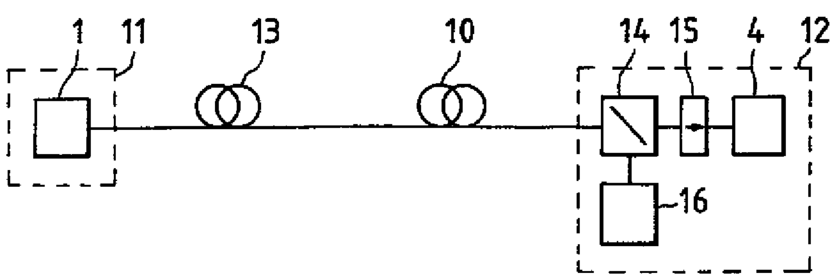


FIG. 7

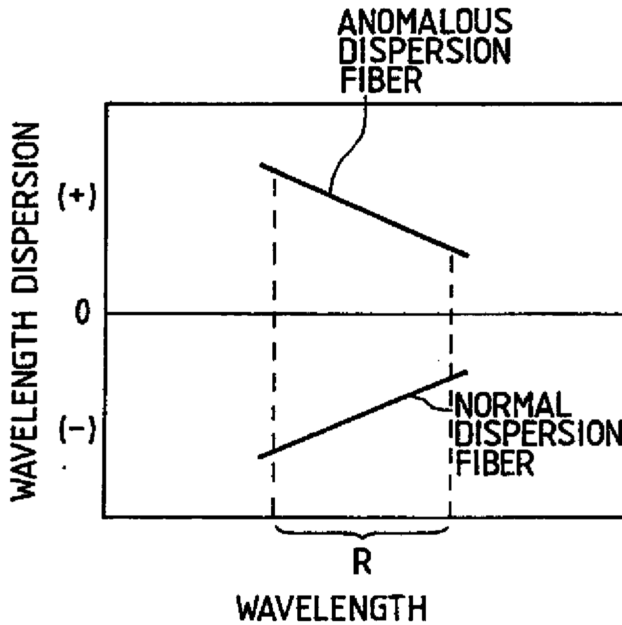

ANOMALOUS DISPERSION FIBER
WAVELENGTH DISPERSION
(+)
0
(−)
NORMAL DISPERSION FIBER
R
WAVELENGTH

FIG. 8

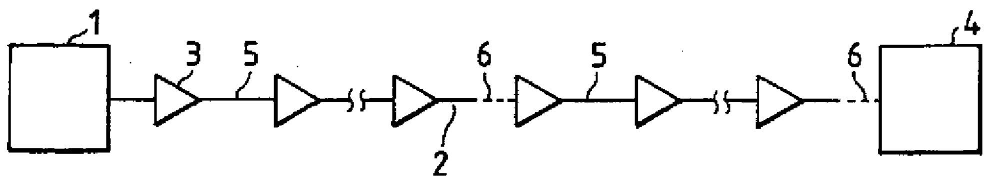

1
3
5
6
5
6
4
2

FIG. 9

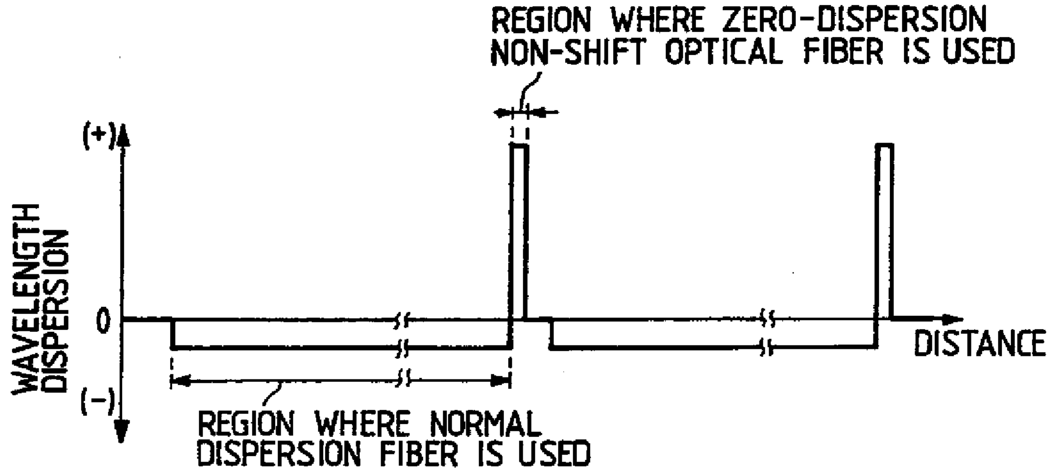


FIG. 10

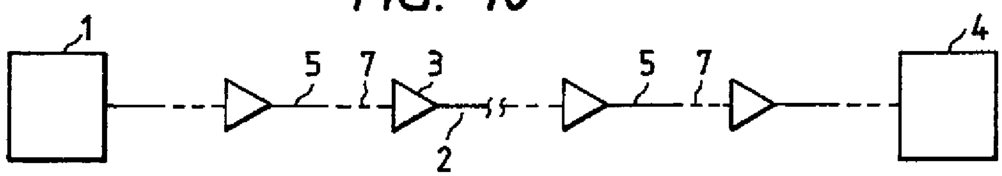


FIG. 11

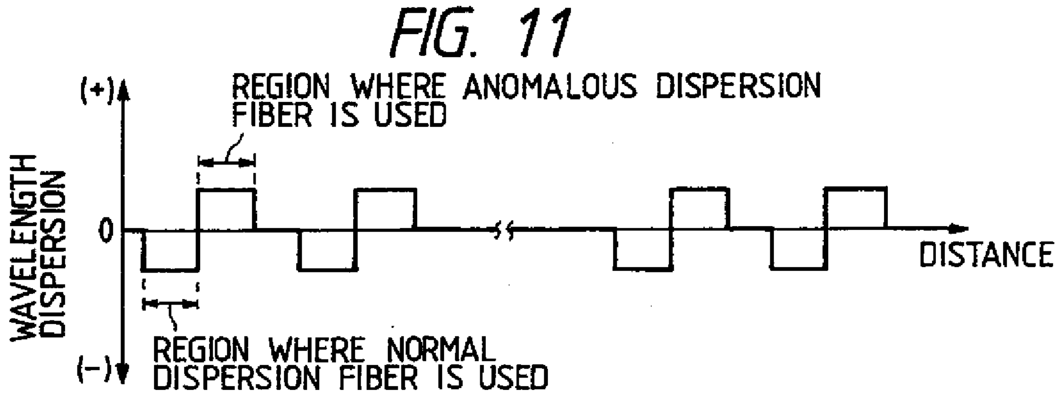
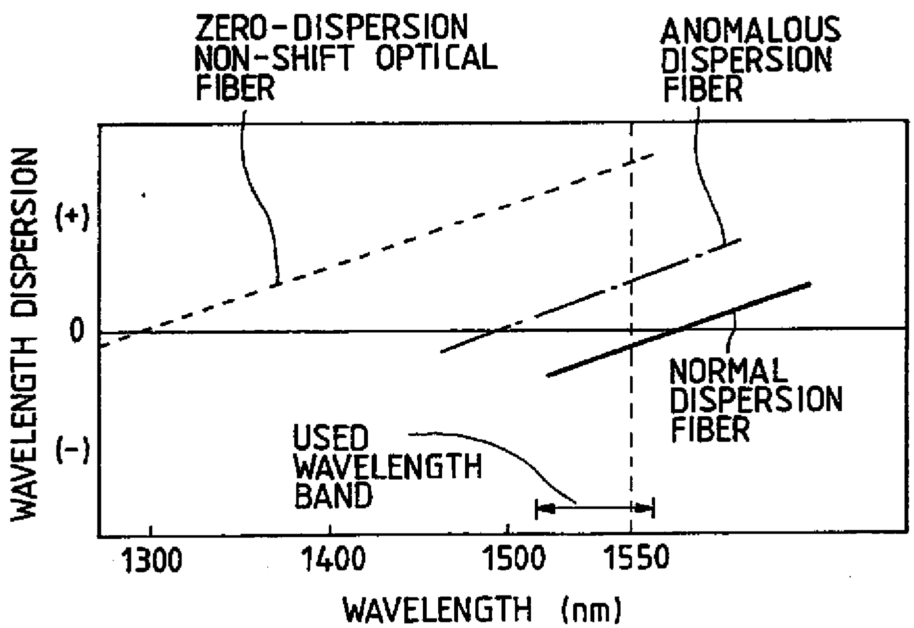


FIG. 12


ZERO-DISPERSION
NON-SHIFT OPTICAL
FIBER
ANOMALOUS
DISPERSION
FIBER
WAVELENGTH DISPERSION
(+)
0
(−)
NORMAL
DISPERSION
FIBER
USED
WAVELENGTH
BAND
1300
1400
1500
1550
WAVELENGTH (nm)

LONG DISTANCE LIGHTWAVE COMMUNICATION SYSTEM

The present invention relates to a long distance lightwave communication system constructed by using an optical fiber transmission path and optical amplifiers, and more particularly relates to a long distance lightwave communication system capable of realizing lightwave communication in a wide range of wavelength without waveform degradation due to four-lightwave mixing excessive accumulation noise and self-phase modulation.

In a long distance lightwave communication system, long distance communication of optical signals can be realized by compensating the transmission loss of an optical fiber through interposing optical amplifiers in an optical fiber transmission path.

In the long distance lightwave communication system, the degradation of transmission waveform is occurred by wavelength dispersion effect due to accumulation of the wavelength dispersion of the optical fiber as the accumulation of wavelength dispersion increases. Therefore, it is required to select an optical fiber so that the zero dispersion wavelength of the optical fiber

agrees with the wavelength of the signal. In other words, since a high gain can be obtained with optical amplifiers and signal light of 1550 nm wavelength band having a low transmission loss of optical fiber is used, a long distance lightwave communication system employs a dispersed shift optical fiber in which the zero dispersed wavelength is shifted to 1550 nm band.

However, when the value of dispersion of an optical fiber under the used wavelength of signal light is zero, the four-lightwave mixing excessive accumulation noise substantially increases. When a very long distance communication or a high speed communication is preformed by using a signal wavelength of which the dispersion wavelength is positive or zero, the four-lightwave mixing excessive accumulation noise becomes too large to neglect its affect. Therefore, when the zero dispersion wavelength, of which the value of dispersion of the optical fiber becomes zero as described above, is used as the signal wavelength, the affect particularly becomes so large that the transmitted waveform is largely deformed to occur an error in receiving of signals.

As to conventional long distance lightwave communication systems to suppress the affect of the four-lightwave mixing excessive accumulation noise, there are proposed various kinds of systems such as a system

employing a dispersed shift optical fiber (hereinafter, referred to as "normal dispersion fiber") of which the value of wavelength dispersion in the signal light wavelength is negative.

FIG.8 shows the long distance lightwave communication system described above. The system is composed of an optical transmitter 1 for outputting light signals having wavelength of 1550 nm, an optical fiber transmission path 2 combined with the normal dispersion fibers 5 described above and common zero-dispersion non-shift optical fibers 6 having a zero-dispersion wavelength in 1300 nm band (the value of wavelength dispersion in wavelength of 1550 nm is positive), optical amplifiers 3 for compensating the transmission loss of the optical fibers by amplifying the light signals in the optical fiber transmission path 2, and an optical receiver 4 for receiving the light signals transmitted.

In the long distance lightwave communication system of such a construction, the zero-dispersion non-shift optical fiber 6 is used for adjusting wavelength dispersion, and the wavelength dispersion accumulated in the normal dispersion fiber 5 is compensated with the zero-dispersion non-shift optical fiber 6. FIG.9 shows the wavelength dispersion in the using wavelength corresponding to the optical fiber transmission path 2 of

FIG.8. The wavelength dispersion in the region of normal dispersion fiber 5 is in the normal dispersion (negative dispersion) and the wavelength dispersion in the region of the zero-dispersion non-shift optical fiber 6 is in the anomalous dispersion (positive dispersion), and consequently the wavelength dispersion of the whole optical fiber transmission path 2 is compensated to nearly zero.

Further, there is proposed a construction of an optical fiber transmission path 2 shown in FIG.10 where a normal dispersion fiber 5 is combined with a dispersion shift optical fiber 7 of which the value of wavelength dispersion in the signal light wavelength is positive (hereinafter, referred to as "anomalous dispersion fiber"). With this construction, the accumulated wavelength dispersion can be also compensated by the normal dispersion fiber 5. FIG.11 shows the wavelength dispersion in the using wavelength corresponding to the optical fiber transmission path 2 of FIG.10. The wavelength dispersion in the region of normal dispersion fiber 5 is in the normal dispersion (negative dispersion) and the wavelength dispersion in the region of the anomalous optical fiber 7 is in the anomalous dispersion (positive dispersion), and consequently the wavelength dispersion of the whole optical fiber transmission path 2 is compensated to nearly

zero.

However, there are some cases where the value of wavelength is reversed from negative to positive or vice versa when wavelength division multiplexing (WDM) transmission is performed, that is, the width of the using wavelength band is changed to a wider range (for instance, 30 nm) in the conventional long distance lightwave communication systems in order to transmit signals with a higher capacity. For example, in the long distance lightwave communication system of FIG.10, as shown in FIG.12, the normal dispersion fiber (solid line) having a negative value of wavelength dispersion in the using wavelength of 1550 nm becomes to have a positive value when the using wavelength is increased larger than 1550 nm, and, as the result, becomes in a positive dispersion similar to the anomalous dispersion fiber (dash-dot line). Therefore, there arises a problem of receiving failure because the wavelength dispersion of the optical fiber transmission path cannot be compensated to nearly zero.

An object of the present invention is to provide a long distance lightwave communication system capable of compensating the wavelength dispersion of an optical fiber transmission path to nearly zero over a wide range of wavelength.

In order to solve the aforementioned problem and to compensate the wavelength dispersion of an optical fiber transmission path over a wide range of wavelength, according to the present invention, the optical fiber transmission path comprises a normal dispersion fiber and an anomalous dispersion fiber. The normal dispersion fiber has a wavelength dispersion characteristic of which the values of wavelength dispersion are in the negative domain excluding zero within the using wavelength band and the gradient of the wavelength dispersion is positive or negative to the using wavelength, the anomalous dispersion fiber has a wavelength dispersion characteristic of which the values of wavelength dispersion are in the positive domain excluding zero within the using wavelength band, and the wavelength dispersion characteristics for the normal dispersion fiber and the anomalous dispersion fiber are nearly symmetrical with respect to the line of zero.

It is preferable that the optical fiber transmission path is divided into two of transmitting-side section and receiving-side section, and the normal dispersion fiber is arranged in the transmitting-side section and the anomalous dispersion fiber being arranged the receiving-side section.

It is also preferable that the optical fiber transmission path comprises a plurality of optical

amplifiers arranged in a predetermined spacing, and the optical fiber transmission path is divided into two of transmitting-side section and receiving-side section in each of the repeating section between the optical amplifiers, the normal dispersion fiber being arranged in the transmitting-side section, the anomalous dispersion fiber being arranged the receiving-side section.

It is also preferable that the optical fiber transmission path is constructed so that the difference between the total summed lengths of the transmitting-side sections and of the receiving-side sections, the difference between the absolute values of the gradient of the value of wavelength dispersion in the transmitting-side section and in the receiving-side section and the difference between the absolute values of the values of wavelength dispersion per unit length in the using wavelength band in the transmitting-side sections and in the receiving-side sections are respectively within 10%.

It is also preferable that the optical fiber transmission path is constructed so that the anomalous dispersion fiber in the last repeating section formed with the optical amplifier in the last stage and the optical receiver is set to a predetermined length, and the value of the overall dispersion of the whole transmitting path in the using wavelength band is compensated to nearly zero.

It is also preferable that the optical fiber transmission path is constructed so that the absolute values of the gradients of wavelength dispersion values of the normal dispersion fiber and the anomalous dispersion fiber are within the range of 0.1 to 0.01 PS/nm^2·km. There, the lower limit of 0.01 PS/nm^2·km is a control value in considering the allowance for manufacturing to keep the gradient of the wavelength dispersion values.

A light signal output from an optical transmitter is transmitted through an optical fiber transmission path and received by an optical receiver. Therein, the light signal is subjected to the affect of negative dispersion in the normal dispersion fiber in the optical fiber transmission path, and subjected to the affect of positive dispersion in the anomalous dispersion fiber. As a result, the value of wavelength dispersion of the optical fiber transmission path is compensated to nearly zero. As the normal dispersion fiber employed is a fiber having a wavelength dispersion characteristic of which the values of wavelength dispersion are in the negative domain within a wide range of the using wavelength band and the gradient of the wavelength dispersion is positive or negative to the using wavelength, And as the anomalous dispersion fiber employed is a fiber having a wavelength dispersion characteristic of which the values of wavelength

dispersion are in the positive domain excluding zero within a wide range of the using wavelength band, and the wavelength dispersion characteristics for the normal dispersion fiber and the anomalous dispersion fiber are nearly symmetrical with respect to the line of zero. Therefore, there is no case where the values of wavelength dispersion of the normal dispersion fiber and the anomalous dispersion fiber are reversed from negative to positive or vice versa, and the wavelength dispersion of an optical fiber transmission path can be compensated to nearly zero when wavelength division multiplexing transmission is performed in a wide range of wavelength.

In the drawings

FIG.1 is an explanatory view showing an embodiment in accordance with the present invention.

FIG.2 is an explanatory view showing a transmission path between optical amplifiers of an embodiment in accordance with the present invention.

FIG.3 is an explanatory graph showing the wavelength dispersion characteristic of an embodiment of an optical fiber in accordance with the present invention.

FIG.4 is an explanatory graph showing the wavelength dispersion characteristic of an embodiment of transmission path in accordance with the present invention.

FIG.5 is an explanatory view showing a second

embodiment in accordance with the present invention.

FIG.6 is an explanatory view showing a third embodiment in accordance with the present invention.

FIG.7 is an explanatory graph showing the wavelength dispersion characteristic of another embodiment of an optical fiber in accordance with the present invention.

FIG.8 is an explanatory view showing a conventional long distance lightwave communication system.

FIG.9 is an explanatory graph showing the wavelength dispersion of a conventional long distance lightwave communication system.

FIG.10 is an explanatory view showing another conventional long distance lightwave communication system.

FIG.11 is an explanatory graph showing the wavelength dispersion in the transmission path of another conventional long distance lightwave communication system.

FIG.12 is an explanatory graph showing the wavelength dispersion characteristic of optical fibers.

A long distance lightwave communication system according to the present invention will be described in detail below, referring to the accompanying drawings.

FIG.1 shows the construction of an embodiment of a long distance lightwave communication system according to the present invention. This long distance lightwave

communication system comprises an optical transmitter 1 for transmitting light signals in a wide wavelength band (for example, 1535 to 1565 nm), an optical fiber transmission path 10 constructed by combining normal dispersion fibers 8 and anomalous dispersion fibers 9, a plurality of optical amplifiers 3 for amplifying the light signals in the optical fiber transmission path 10, and an optical receiver 4 for receiving the transmitted light signals.

The optical fiber transmission path 10 is, as shown in FIG.2, constructed by dividing each of the transmission path in the repeating section of the optical amplifiers 3 into two, by arranging the normal dispersion fiber 8 in the output-side section a of the optical amplifier 3 where comparatively strong light signals are transmitted and the anomalous dispersion fiber 9 in the input-side section b of the optical amplifier 3 where comparatively weak light signals are transmitted, respectively, and by connecting the normal dispersion fiber and the anomalous dispersion fiber in each repeating section in series.

The wavelength dispersion characteristics of the normal dispersion fiber 8 and the anomalous dispersion fiber 9 will be described here.

Each of FIG.3 and FIG.7 shows the relationship between the values of wavelength dispersion and the using

wavelength for the normal dispersion fiber 8 and the anomalous dispersion fiber 9. The normal dispersion fiber 8 has the values of wavelength dispersion in the negative domain within the using wavelength range R and a negative gradient (negative dispersion slope) to the using wavelength as shown in FIG.3 or a positive gradient (positive dispersion slope) to the using wavelength as shown in FIG.7. On the other hand, the anomalous dispersion fiber 9 has the values of wavelength dispersion in the positive domain within the using wavelength range R and a positive gradient (positive dispersion slope) to the using wavelength as shown in FIG.3 or a negative gradient (negative dispersion slope) to the using wavelength as shown in FIG.7. Further, both of the absolute values of the wavelength dispersion in each wavelength for the both fibers 8, 9 are nearly equal to each other, and consequently the distributions of the values of wavelength dispersion are symmetrical in regard to the zero line of the wavelength dispersion.

The difference between the total summed lengths of the sections of the normal dispersion fiber 8 and of the sections of the anomalous dispersion fiber 9, the difference between the absolute values of the gradient of the value of wavelength dispersion for the normal dispersion fiber 8 and the anomalous dispersion fiber 9

and the difference between the absolute values of the values of wavelength dispersion per unit length in the using wavelength band for the normal dispersion fiber 8 and the anomalous dispersion fiber 9 are respectively within 10%. Further, the absolute values of the gradients of wavelength dispersion values of the normal dispersion fiber and the anomalous dispersion fiber are within the range of 0.1 to 0.01 $PS/nm^2 \cdot km$.

The normal dispersion fiber 8 and the anomalous dispersion fiber 9 can be realized by designing the wavelength characteristics of the optical fibers. In order to obtain a wavelength dispersion characteristic having a negative gradient in a given wavelength band, an optical fiber having a W-shaped refractive index is employed, and in order to obtain a wavelength dispersion characteristic having a positive gradient, an optical fiber having a step-shaped refractive index is employed. The amount of shift in the x-axis or the y-axis can be controlled by properly selecting the materials for the core and the cladding of the optical fiber. The amount of the gradient of the wavelength dispersion characteristic can be controlled by properly varying the structure of the core and the cladding, that is, the dimensions and the refractive indexes of the core and the cladding.

The operation of the present invention will be

described below.

When light signals having wavelengths in the using wavelength are output from the optical transmitter 1, the light signals are transmitted in the optical fiber transmission path 10 while the light signals are being amplified with the optical amplifiers 3 spaced in a given distance and then received with the optical receiver 4.

Therein, the light signals output from the optical amplifier 3 is subjected to the affect of negative dispersion in the output-side section a of the optical amplifier 3 while being transmitted through the normal dispersion fiber 8, and then subjected to the affect of positive dispersion in the input-side section b of the optical amplifier 3 while being transmitted through the anomalous dispersion fiber 9. As the result, the value of wavelength of the optical fiber transmission path 10 from the optical transmitter 1 to the optical receiver 4 is compensated to nearly zero, and accordingly the light signals without waveform degradation can be transmitted to the optical receiver 4 by preventing the waveform degradation due to self-phase modulation. Since the normal dispersion fiber 8 is employed in the output-side section of the optical amplifier 3, it is possible to suppress lower the four-wave mixing excessive accumulation noise which increases as the intensity of light signal is

increased.

In the long distance lightwave communication system, the values of wavelength dispersion of the normal dispersion fiber 8 and the anomalous dispersion fiber 9 are not reversed from positive to negative or vice versa and accordingly the wavelength dispersion of the optical transmission path can be compensated over a wide range of wavelength to nearly zero even when an wavelength division multiplexing transmission is performed, since the normal dispersion fiber 8 has a wavelength dispersion characteristic of which the values of wavelength dispersion are in the negative domain excluding zero within the using wavelength band and the gradient of the wavelength dispersion is positive or negative to the using wavelength and the anomalous dispersion fiber 9 has a wavelength dispersion characteristic of which the values of wavelength dispersion are in the positive domain excluding zero within the using wavelength band and the wavelength dispersion characteristics for the normal dispersion fiber 8 and the anomalous dispersion fiber 9 are nearly symmetrical with respect to the line of zero. In the case where the wavelength division multiplexing transmission in the above embodiment is performed with the using wavelength band of 1535 to 1565 nm, it is also possible to perform a multiplexing transmission of 38

waves spaced every 0.8 nm.

FIG.5 shows the construction of a second embodiment of a long distance lightwave communication system according to the present invention. The long distance lightwave communication system comprises a transmitting station 11 having an optical transmitter 1 connecting an optical amplifier 3A just after the optical transmitter, a receiving station 12 having an optical amplifier 3B just before the optical receiver, and an optical fiber transmission path 10 interposed between the transmitting station 11 and the receiving station 12 to transmit light signals from the transmitting station 11 to the receiving station without repeater.

The optical fiber transmission path 10 employs a normal dispersion fiber in the output side of the transmitting station 11 and an anomalous dispersion fiber in the input side of the receiving station, and these are connected to each other in series. The optical fibers described in the first embodiment are employed as the normal dispersion fiber and the anomalous dispersion fiber.

In such an embodiment similar to the first embodiment, it is possible to perform a lightwave transmission over a wide wavelength band without the four-lightwave mixing excessive accumulation noise and the waveform degradation due to self-phase modulation, and it

is possible to extend the repeater-less distance and, at the same time, to make it easy to maintain and manage the optical amplifiers.

FIG.6 shows the construction of a third embodiment of a long distance lightwave communication system. The long distance lightwave communication system is constructed by inserting an optical fiber transmission path 10 formed by combining the two kinds of the optical fibers described in the first and the second embodiments and an erbium doped fiber 13 between the transmitting station 11 and the receiving station 12, and by providing an exciting light source 16 to input excited light for amplifying the light signals into the receiving station 12 through an optical multi/demultiplexing circuit 14 and an isolator 15 for passing only the light signals in one direction. In such a construction, it is possible to obtain the same effect as in the first and the second embodiments with the remote-pumping type optical amplifying system without repeater.

The optical amplifier 3B in the second embodiment may be omitted, and the front-end optical amplifier or the back-end optical amplifier or both the front-end optical amplifier and the back-end optical amplifier may be inserted into the stations 11, 12 in the end terminal.

As having been described above, in the long distance

lightwave communication system according to the present invention, the normal dispersion fiber has a wavelength dispersion characteristic of which the values of wavelength dispersion are in the negative domain excluding zero within the using wavelength band and the gradient of the wavelength dispersion is positive or negative to the using wavelength, the anomalous dispersion fiber has a wavelength dispersion characteristic of which the values of wavelength dispersion are in the positive domain excluding zero within the using wavelength band, and the wavelength dispersion characteristics for the normal dispersion fiber and the anomalous dispersion fiber are nearly symmetrical with respect to the line of zero. Therefore, the wavelength dispersion of the optical fiber transmission path can be compensated to nearly zero over the wide range of wavelength, and consequently it is possible to improve the wavelength division multiplexing transmission in a wide range of wavelength band.

CLAIMS

1. A long distance lightwave communication system for amplifying light signals output from an optical transmitter using an optical amplifier and transmitting the amplified light signals to an optical receiver through an optical fiber transmission path, wherein

said optical fiber transmission path comprises a normal dispersion fiber and an anomalous dispersion fiber, the normal dispersion fiber having a wavelength dispersion characteristic of which the values of wavelength dispersion are in the negative domain excluding zero within the using wavelength band and the gradient of the wavelength dispersion is positive or negative to the using wavelength, the anomalous dispersion fiber having a wavelength dispersion characteristic of which the values of wavelength dispersion are in the positive domain excluding zero within the using wavelength band, the wavelength dispersion characteristics for the normal dispersion fiber and the anomalous dispersion fiber being nearly symmetrical with respect to the line of zero.

2. A long distance lightwave communication system according to claim 1, wherein said optical fiber transmission path is divided into two of transmitting-side section and receiving-side section, said normal dispersion fiber being arranged in said transmitting-side section,

said anomalous dispersion fiber being arranged said receiving-side section.

3. A long distance lightwave communication system according to claim 1, wherein said optical fiber transmission path comprises a plurality of optical amplifiers arranged in a predetermined spacing.

4. A long distance lightwave communication system according to claim 3, wherein said optical fiber transmission path is divided into two of transmitting-side section and receiving-side section in each of the repeating section between a plurality of said optical amplifiers, said normal dispersion fiber being arranged in said transmitting-side section, said anomalous dispersion fiber being arranged said receiving-side section.

5. A long distance lightwave communication system according to any one of claim 2, claim 3 and claim 4, wherein said optical fiber transmission path is constructed so that the difference between the total summed lengths of said transmitting-side sections and of said receiving-side sections, the difference between the absolute values of the gradient of the value of wavelength dispersion in said transmitting-side section and in said receiving-side section and the difference between the

absolute values of the values of wavelength dispersion per unit length in the using wavelength band for said transmitting-side sections and for said receiving-side sections are respectively within 10%.

6. A long distance lightwave communication system according to claim 4, wherein said optical fiber transmission path is constructed so that said anomalous dispersion fiber in the last repeating section formed with the optical amplifier in the last stage and said optical receiver is set to a predetermined length, and the value of the overall dispersion of the whole transmitting path in the using wavelength band is compensated to nearly zero.

7. A long distance lightwave communication system according to any one of claim 1, claim 2, claim 3, claim 4, claim 5 and claim 7, wherein said optical fiber transmission path is constructed so that the absolute values of the gradients of wavelength dispersion values of said normal dispersion fiber and said anomalous dispersion fiber are within the range of 0.1 to 0.01 $PS/nm^2 \cdot km$.

8. A long distance lightwave communication system substantially as herein described with reference to, and as illustrated in, Figs. 1 to 4 or Fig. 5, or Fig. 6, or Fig. 7 of the accompanying drawings.

Amendments to the claims have been filed as follows:

1. A long distance lightwave communication system for amplifying light signals output from an optical transmitter using an optical amplifier and transmitting the amplified light signals to an optical receiver through an optical fiber transmission path, wherein

said optical fiber transmission path comprises a normal dispersion fiber and an anomalous dispersion fiber, the normal dispersion fiber having a wavelength dispersion characteristic of which the values of wavelength dispersion are in the negative domain excluding zero within the using wavelength band and the gradient of the wavelength dispersion characteristic is positive with respect to the using wavelength, the anomalous dispersion fiber having a wavelength dispersion characteristic of which the values of wavelength dispersion are in the positive domain excluding zero within the using wavelength band and the gradient of the wavelength dispersion characteristic is negative with respect to the using wavelength.

2. A long distance lightwave communication system according to claim 1, wherein said optical fiber transmission path is divided into a transmitting-side

section and a receiving-side section, said normal dispersion fiber being arranged in said transmitting-side section, and ,said anomalous dispersion fiber being arranged in said receiving-side section.

3. A long distance lightwave communication system according to claim 1, wherein said optical fiber transmission path comprises a plurality of optical amplifiers arranged in a predetermined spacing.

4. A long distance lightwave communication system according to claim 3, wherein said optical fiber transmission path is divided into a transmitting-side section and a receiving-side section between adjacent ones of said plurality of optical amplifiers, said normal dispersion fiber being arranged in said transmitting-side section, and said anomalous dispersion fiber being arranged in said receiving-side section.

5. A long distance lightwave communication system according to any one of claim 2, claim 3 and claim 4, wherein said optical fiber transmission path is constructed so that the difference between the total summed lengths of said transmitting-side sections and of said receiving-side sections, the difference between the absolute values of the gradient of the value of

wavelength dispersion in said transmitting-side section and in said receiving-side section and the difference between the absolute values of the values of wavelength dispersion per unit length in the using wavelength band for said transmitting-side sections and for said receiving-side sections are respectively within 10%.

6. A long distance lightwave communication system according to claim 4, wherein said optical fiber transmission path is constructed so that said anomalous dispersion fiber in the last repeating section formed with the optical amplifier in the last stage and said optical receiver is set to a predetermined length, and the value of the overall dispersion of the whole transmitting path in the using wavelength band is compensated to nearly zero.

7. A long distance lightwave communication system according to any one of claim 1, claim 2, claim 3, claim 4, claim 5 and claim 6, wherein said optical fiber transmission path is constructed so that the absolute values of the gradients of wavelength dispersion values of said normal dispersion fiber and said anomalous dispersion fiber are within the range of 0.1 to 0.1 $PS/nm^2.km$.

8. A long distance lightwave communication system substantially as herein described with reference to, and as illustrated in, Figs. 1 to 4 or Fig. 5, or Fig. 6, or Fig. 7 of the accompanying drawings.

The Patent Office

2·6

Application No:	GB 9522356.6	**Examiner:**	Dr E P Plummer
Claims searched:	all	**Date of search:**	19 January 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4B(BK18)

Int Cl (Ed.6): H04B

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP0554714A1	CORNING - eg abstract, page 5 lines 37 to 41, page 8 lines 5 to 18	1,2,3,4,6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.